4.0 METHODS

4.1 DELINEATING "DISTINCT POPULATION SEGMENTS" UNDER THE ESA

Under the ESA, NMFS makes listing determinations after conducting a review of the status of a species and after taking into account efforts being made to protect the species (ESA section 4(b)(1)(A)). Establishing what constitutes a "species" is a critical initial step in this process.

The term "species" under the ESA, "includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species or vertebrate fish or wildlife which interbreeds when mature" (ESA, section 3(15)). The ESA does not define the term "distinct population segment" (DPS) and so NMFS has defined what constitutes a DPS for Pacific salmon to provide a technically sound and consistent basis for making listing decisions.

> *To qualify as a DPS, a Pacific salmon population must be substantially reproductively isolated and represent an important component in the evolutionary legacy of the biological species. A Pacific salmon population meeting these criteria is consider to be an Evolutionarily Significant Unit (ESU: 56 FR 58612, November 20, 1991, Waples 1991).*

These criterion for defining a Pacific salmon DPS have been upheld as valid both scientifically and legally. The United States Congress directed the National Research Council (NRC Committee on Scientific Issues in the Endangered Species Act) to review how the term "species" has been used to implement the ESA, and what units would best serve the purposes of the ESA. In response to this task, the Council first concluded that "the ESA's inclusion of all three categories for preservation - species, subspecies, and distinct population segments, (at least for vertebrate species),- correct and appropriate" (NRC 1995). They went on to say that for vertebrates in general, "an evolutionarily distinct population segment that is geographically or otherwise isolated from other population segments" constitutes an "Evolutionary Unit (EU) or DPS and that "it seems likely that the application of either the EU or NMFS' ESU concept would lead to similar results most of the time." *In Alsea Valley Alliance v Evans* (161F. Supp. 2d 1154, D. Oreg. 2001; Alsea decision), the court found that "The NMFS interpretation of what constitutes a "distinct population segment" is a permissible agency construction of the ESA". Further, the court found that "Specifically, the NMFS creation of an ESU and the factors used to define it, geography and genetics, are within permissible limits under the ESA."

The approach for defining ESUs under the proposed Hatchery Listing Policy does not represent a change from previous agency practice. Delineating an ESU involves identifying the full portfolio of existing genetic resources or raw material. Hatchery-origin fish are factored into delineating an ESU. Under NMFS' 1993 Interim Policy on Artificial Propagation of Pacific Salmon under the ESA, "Genetic resources important to the species' evolutionary legacy may reside in hatchery fish as well as natural fish, in which case the hatchery fish can be considered part of the biological ESU" (58 FR 17573, April 5, 1993). The ESU approach to defining a DPS or ESU emphasizes that "the evolutionary legacy of a species is the genetic variability that is a product of past evolutionary events, and that represents the reservoir upon which future evolutionary potential depends" (Waples 1995).

An ESU's reservoir of genetic resources reside in independent populations comprising the ESU. Independent populations in turn may include natural-origin fish, hatchery-origin fish, or combinations of both. Hatchery-origin fish that are genetically no more than moderately divergent from a natural population in the ESU are included in the ESU (NMFS 2004d). Genetic data, life-history and population dynamics information, and characteristic propagation program practices (the source of broodstock and broodstock collection and mating protocols in particular), are key factors in determining the extent of any divergence between natural and hatchery-origin fish. For example, artificial propagation practices leading to the reproductive isolation of hatchery-origin fish, would be expected to promote divergence between natural and hatchery-origin fish and the exclusion of those hatchery-origin fish from an ESU. This document and the SSHAG Report (NMFS 2003a) assess the relatedness of West Coast hatchery and natural-origin salmon for the purposes of delineating ESUs under the ESA.

4.2 Determining the Biological Status of an ESU's Component Populations

Once an ESU is delineated, its biological status can be determined. NMFS is responsible for determining whether species, subspecies, or distinct population segments (DPSs) of Pacific salmon are threatened or endangered and warrant protection under the ESA (16 U.S.C. 1531 et seq.).

Section 4(b)(1)(A) of the ESA requires NMFS to make status determinations (the term "status" refers to the ESA listing status of "threatened," "endangered," or listing not warranted) based solely on the best scientific and commercial data available after conducting a review of the status of the species and after taking into account efforts being made to protect the species. Section 3 of the ESA defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range" and a threatened species as one "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Accordingly, NMFS follows four steps in making its status determinations for Pacific salmon: (1) NMFS first determines what fish constitute an ESU (hatchery-origin and natural-origin fish included), (2) NMFS determines the biological status of the ESU and the factors that have led to any decline in ESU viability, (3) NMFS then assesses efforts being made to protect the ESU, determining if these efforts are adequate to mitigate any threats to the ESU, and (4) based on the foregoing determinations, NMFS proposes a listing determination of "endangered," "threatened," or "not warranted."

The proposed Hatchery Listing Policy represents a change from previous agency practice in how hatchery-origin fish are considered in extinction risk assessments. Under NMFS' interim artificial propagation policy for Pacific salmonids (Interim Policy; 58 FR 17573, April 5, 1993), "evaluations of the status of the ESU in listing and delisting determinations will depend on the viability of the population in the natural habitat and on the status of ongoing conservation measures." Under a new Proposed Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead (NOAA Fisheries 2004d), "Status determinations for Pacific salmonid ESUs will be based on the likelihood of extinction of an entire ESU" (i.e., the biological status of the ESU will be assessed by taking into account both the natural-origin and hatchery-origin fish included in the ESU).

The biological status of an ESU depends upon the biological status of its component parts or the independent populations comprising it (McElhany *et al.* 2000, Ruckelshaus *et al.* 2002). Independent populations are units for which it is biologically meaningful to examine extinction risks that derive from intrinsic factors such as demographic, genetic, or local environmental stochasticity. A population is considered independent if its population dynamics and risk of extinct are substantially independent of other populations (McElhany et al. 2000). Independent populations can be comprised of natural-origin fish only, combinations of natural-origin and hatchery-origin fish, or of hatchery-origin fish exclusively. Populations identified by NMFS' Technical Recovery Teams are considered "independent" for the purposes of this report.

McElhany *et al.* (2000) also provides consistent and transparent criteria and constitutes the best scientific and commercial information available (as required under section 4(b) of the ESA) for determining the biological status of independent populations that make up an ESU. These criteria are abundance, productivity, diversity, and spatial distribution. In assessing extinction risk at the independent population scale, the following criteria were used.

Abundance: 1. spawning ground escapement of natural-origin fish included in the ESU, 2. spawning ground escapement of hatchery-origin fish included in the ESU, 3. total returns (on the spawning grounds and to hatcheries), of fish included in the ESU (natural-origin and hatchery-origin), 4. Original and extant number of populations in the ESU, 5. the number of natural populations with minimal genetic contribution from hatchery-origin fish, and 5. the number of natural populations that are stable or increasing and have adequate spawning and rearing habitat.

Productivity: 1. natural-origin fish productivity in the absence of any artificial propagation intervention or subsidy (e.g., natural-origin fish survival rates and replacement rates over the entire life cycle), 2. hatchery-origin fish productivity (e.g., egg-to-adult survival rates, replacement rates, and replacement rates of naturally spawning hatchery-origin fish), 3. spawner carcass contribution to instream nutrient levels, 4. natural spawner success at finding mates, 5. predation on natural-origin fish by planted hatchery-origin fish, and 6. competition between natural-origin and hatchery-origin fish for food and space (primarily in freshwater habitats).

Diversity: 1. genetic and life history characteristic similarity between natural-origin fish and hatchery-origin fish included in the ESU, 2. status of different forms (e.g., spring run fish versus fall run chinook), and 3. different propagation program practices (e.g., the level and frequency for incorporating natural-origin fish into broodstocks, the level and frequency of using broodstock from outside the area, practices that promote life history characteristics different from the associated natural population, etc.).

Spatial Distribution: 1. distribution of natural-origin fish, 2. distribution of hatchery-origin fish (both hatchery-origin fish included in and not included in the ESU), and 3. reintroductions and expansions into former habitat by fish included in the ESU.

4.3 DETERMINING AN ESU'S BIOLOGICAL STATUS

This report evaluates the benefits and risks of artificial propagation at two levels: the level of individual populations and the level of ESUs. First, the effects of all associated hatchery programs were evaluated for each of the VSP criteria at the level of the target natural population. Then, the collective benefits and risks were evaluated for all associated hatchery populations (both in and out of the ESU) at the scale of the ESU. Finally, these ESU-level effects of hatchery programs on abundance, productivity, spatial structure, and diversity were evaluated to determine the extinction risk of the entire ESU, including natural and hatchery components.

Considerations that factor into determining the biological status of an ESU include the following:

1. Abundance, productivity, diversity, and spatial distribution of the ESUs component independent populations,

2. Multiple populations reduce ESU extinction risk. For ESUs comprised of a single population, greater abundance, productivity, diversity, and spatial distribution of that population (i.e., greater resiliency) is necessary to reduce any extinction risk,

3. Natural populations that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat reduce the risk of extinction of an ESU (NMFS 2004d),

4. Natural populations with minimal genetic contribution from hatchery-origin fish, can provide a point of comparison for the evaluation of the effects of hatchery-origin fish on the likelihood of extinction of an ESU (NMFS 2004d),

5. Artificial propagation can either reduce or increase the likelihood of extinction of an ESU. The effects of artificial propagation on the likelihood of extinction of an ESU will depend on how hatchery-origin fish affect abundance, productivity, genetic diversity, and spatial distribution of the ESU (NMFS 2004d). For details, see Determining the Biological Status of an ESUs Component Populations above,

6. The track record of propagation programs using hatchery-origin fish included in an ESU based on a. experience or history (i.e., duration of the programs), b. program productivity (i.e., is survival high enough for the program to be self-sustaining),and c. certainty of continued implementation (i.e., is funding and necessary authorizations reasonably certain), and

7. On-going and effective monitoring and evaluation programs that determine the effect of propagation programs on the biological status of an ESU.